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& MILLER, INC.

Consulting Ground-Water Geologists and Hydrologists

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INVESTIGATION OF GROUND-WATER CONDITIONS
AT THE W.G. KRUMMRICH PLANT
MONSANTO COMPANY
SAUGET, ILLINOIS

FIRST QUARTERLY REPORT

March 1984

Actions From 3/20/84 mtg

G/M
- To Keep marked up Draft
- To Send Protocols w/1 week (Well inst & Sampling) Well Dev.

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CONTENTS

CONTENTS

Page

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INTRODUCTION

Geraghty & Miller, Inc. was retained by the Monsanto Company to study ground-water conditions at the W.G. Krummrich plant in Sauget, Illinois. The purpose of the investigation is to determine the direction and rate of lateral ground-water flow and the concentrations of various chemical constituents in the upper 10 feet of the saturated zone.

During November and December 1983, twelve wells were constructed on the W.G. Krummrich plant. Three 6-inch diameter wells were installed and were equipped with water-level recorders and the remaining nine wells are 2 inches in diameter. Three rounds of water-level measurements were made on November 17, December 16, 1983, and January 3, 1984, and samples were collected from all of the wells. A detailed description of the field investigation is provided in Appendix A. Appendix B contains Tables 1 through 7, showing well construction details, water-level measurements, and analytical results. The configurations of the water-table, distributions in ground water of various constituents, hydrographs, and well construction are shown in Figures 1 through 10 which are included as Appendix C. The geologic logs of wells are in Appendix D.

HYDROGEOLOGY

Lithology

The W.G. Krummrich Plant is situated on unconsolidated valley fill deposits and it is composed of recent alluvium and glacial valley-train material. These unconsolidated deposits are underlain by Mississippian and Pennsylvanian rocks consisting of limestone and dolomite with lesser amounts of sandstone and shale. The valley fill has an average thickness of about 100 feet.

Recent alluvium constitutes the major portion of the valley fill and it is composed of fine-grained materials with a low permeability. The grain-size distribution becomes coarser with increasing depth. Recent alluvium rests on older deposits, which, in many cases, include valley-train materials. The valley-train materials are generally medium to coarse sand and gravel which also increase in grain size with depth.

Based on information from drilling Monitoring Wells 1 through 12, the upper portion of the water-table zone consists of very fine gray and brown sand which is silty in places. The eastern part of Monsanto's property in the area of Wells 1, 10, 11, and 12 has approximately 6 to 10 feet of silt or clay overlying the very fine sand (Appendix D). Thinner seams or lenses of silt and clay exist at most of the other drilling locations.

Ground-Water Movement

The water-table configuration in the study area is shown on Figures 1, 2, and 3 (Appendix C), with water-level data provided in Table 1 (Appendix B). These figures indicate that a water-table mound exists beneath the plant process area and the horizontal component of ground-water flow is radially away from this mound. The reason for the existence of the mound is not clear. Ground-water movement beneath the western portion of Monsanto's property is toward the Mississippi River.

In addition to the lateral component of ground-water flow there may also be a vertical component, especially if pumpage from deep wells has induced a downward head gradient. Without deep monitoring wells the vertical ground-water flow component cannot be determined.

The water-level records from Wells 1, 2, and 3 (Figure 4, Appendix C) suggest that pumpage affects the shallow saturated zone. Comparison of ground-water levels with the stage level of the Mississippi River at U.S. Engineers Depot, Missouri (about 0.5 mile down-river from Sauget), indicates that changes in river stages are not responsible for changes in the water-table elevation. Rather than correlating with river stage, the water table elevation seems to change abruptly and regularly with time which is indicative of a response to pumpage.

Ground-Water Velocity

Slug tests were carried out on Wells 1, 2, and 3 (the 6-inch monitoring wells) to determine aquifer transmissivity, the storage coefficient and hydraulic conductivity (Table 2, Appendix B). The testing procedures and subsequent analyses are described in the Field Investigation (Appendix A).

Using maximum and minimum permeability values, maximum and minimum hydraulic gradients determined from Figures 1, 2, and 3 (Appendix C), and an assumed effective porosity of 20 percent, maximum and minimum horizontal ground-water velocities of 0.083 feet per day (30.3 feet per year) and 0.0042 feet per day (1.5 feet per year) were calculated for the upper portion of the water-table zone. Dissolved constituents in this zone would generally move at the same rate or somewhat less depending on the degree to which they are attenuated through bacterial action, adsorption, degradation, and hydrodynamic dispersion.

These velocity values were determined from the following form of Darcy's Law:

$$V = \frac{KI}{7.48n}$$

where

V = velocity, in feet per day,

K = hydraulic conductivity of the deposits in the direction of flow, in gallons per day per square foot,

I = hydraulic gradient, in feet per foot, and

n = effective porosity, which is dimensionless.

The maximum velocity was calculated using the maximum water-table gradient of 7 ft/1,300 ft from the November 17, 1983 water-table configuration (Figure 1, Appendix C) along with the maximum hydraulic conductivity of 23 gpd/ft^2 (Table 2, Appendix B). The minimum velocity was determined using the minimum water-table gradient 6 ft/1,800 ft from the January 31, 1984 water-table configuration (Figure 3, Appendix C) and the minimum hydraulic conductivity of 1.9 gpd/ft^2 (Table 2, Appendix B).

GROUND-WATER QUALITY

The water samples collected from all 12 monitoring wells were analyzed by Envirodyne Engineers, Inc. St. Louis, Missouri, for the U.S. Environmental Protection Agency's (USEPA) list of priority pollutant parameters (Table 3, Appendix B). The samples were also analyzed for total organic carbon (TOC), total organic halogen (TOX), total phenols, pH, specific conductance, and cyanide. The analytical results are provided in Tables 4 and 5 (Appendix B) along with pH, temperature, and specific conductance, which were measured in the field. The organic analyses were performed using gas chromatography/mass spectrometry (GC/MS). The distributions of specific conductance, total organic carbon (TOC), total organic halogenated compounds (TOX), total phenols, and total organic priority pollutant compounds in ground water, are provided in Figures 5 through 9 (Appendix C).

In order to check on Envirodyne's laboratory performance, blind replicate samples for Wells 1 and 2 were collected in the field and analyzed for the indicator parameters only. Except for TOC, the variability of results between the two samples is within acceptable limits. The first set of TOC results for Wells 1 and 2 were three times higher than the replicate values. At Geraghty & Miller, Inc.'s request the TOC analyses were repeated on samples for Wells 1 and 2 with mixed results (Table 4). As an internal check on their own performance, Envirodyne analyzed the well water from Well 9 twice for TOC and the metals. In addition, the organic priority pollutant compounds for Well 12 were also checked internally by Envirodyne.

Inorganic Constituents and Indicator Parameters

The USEPA drinking water standards for each parameter investigated are included in Table 4 (Appendix B). The chemical results for metals are well within Federal limits except for Well 1 (chromium), Well 2 (cadmium and lead), Well 3 (cadmium, chromium and zinc), and Well 12 (cadmium and selenium).

Temperature and pH all fall within the normal range of values for ground water. The specific conductance of samples from Wells 9 and 12 is comparatively high, and may be related to the temporary salt pile that is located only 100 feet away. Salt spreading over much of Monsanto's roadways may be responsible for some elevated conductivity readings.

Organic Constituents

A comparison of methylene chloride results with those detected in the laboratory blanks indicates that the presence of methylene chloride is probably a laboratory artifact. Personal communication with laboratory personnel has confirmed that the glassware initially is cleaned with methylene chloride before it is rinsed with deionized water and then baked. Methylene chloride is also used as an extracting solvent in the laboratory.

The distribution of organic compounds follows the distribution of inorganic parameters such as specific conductance, fairly closely, with the highest concentrations found at Wells 9 and 12. The organic chemicals found in concentrations greater than 100 ug/L are benzene, chlorobenzene, 2-chlorophenol, pentachlorophenol, and 1,2-dichlorobenzene.

Respectfully submitted,

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March 13, 1984

CER 093578

APPENDIX A

Field Investigation

FIELD INVESTIGATION

Monitoring-Well Installation

John Mathes and Associates, Inc., Columbia, Illinois, installed 12 monitoring wells under Geraghty & Miller, Inc.'s direction. At well locations 4 through 12, an 8-inch diameter hole was drilled with a power auger to approximately 15 feet below the water table. Split-spoon samples were collected at 5-foot intervals, described and stored in jars. Below the water table, water was added to the borehole during drilling to prevent very fine sand from heaving up inside the augers. Appendix D contains the geologic logs for each site. A 15-foot length of 2-inch diameter, 6-slot, stainless steel Johnson well screen coupled to 2-inch steel casing was installed through the hollow-stem augers to approximately 12 feet below the water table, in anticipation that the water table will rise during wetter months of the year. After the auger flytes were withdrawn, a portion of the annular space adjacent to the well screen filled with sand as the formation collapsed around the well screen. The remainder of the annular space was gravel packed up to 3 feet above the top of the screen.

A 1-foot layer of bentonite pellets was used to separate the gravel pack from a bentonite/cement slurry that was pumped or poured into the annulus above the pellets to within 2 feet of land surface. Pre-mix cement was placed in the remaining annulus and a steel protective pipe with a locking cap was set over the well into the cement. A construction diagram for a typical monitoring well is provided in Figure 10, while a complete summary of construction details is included in Table 6.

Each well was developed using compressed nitrogen and air, and bladder/ peristaltic pumps to ensure that the well screen was open to the aquifer and that all water added to each borehole during drilling had been removed. The auger flytes and drilling tools were either steam cleaned or washed with potable water between drilling sites to prevent cross-contamination of wells should any contamination exist.

At well locations 1, 2, and 3, a 6-inch well was required in order to accommodate a water-level recorder. At these sites an 8-inch diameter hole was drilled and sampled to about 15 to 20 feet below the water table. The augers were removed and the borehole was then reamed to a 9.5-inch diameter with a slag bit using bentonite drilling fluid to keep the hole open. A 6-inch diameter, 6-slot, 10-foot long stainless steel Johnson well screen coupled to 6-inch steel casing was set approximately 2 feet below water table. Placing the well screen at a 2-foot depth below the water table was required for the permeability tests performed on these wells. All three wells were constructed in the same manner as the 2-inch wells (Figure 10, Table 6). Each well was developed with a submersible pump and compressed air. However, it was necessary to add sodium hexametaphosphate (dispersing agent) to Wells 2 and 3 in order to remove all of the drilling fluid.

Water-Level Measurements

Water-level measurements were made in all 12 monitoring wells on November 17, December 16, 1983, and January 1, 1984. These data are provided in Table 1. In addition, the Mississippi River stage is also included as determined by the U.S. Corps of Engineers from the U.S. Engineers Depot, Missouri, located about 0.5 mile downriver from the study area. The elevation of the top of the well casings (2-inch wells) and the elevation to the top of the recorder shelter base (6-inch wells) was surveyed to the nearest 0.01 foot relative to mean sea level by Lopinot and Weber, Inc., St. Louis, Missouri.

Upon completion of the ground-water sampling program, continuous water-level recorders, equipped with monthly clocks were installed at Wells 1, 2 and 3. John Mathes and Associates, Inc. personnel will reset the recorders every first and second month between quarterly ground-water sampling events.

Water Sample Collection

The first of four quarterly ground-water sampling programs was carried out November 15-17, 1983. Each well was sampled for U.S. EPA Priority Pollutants (excluding asbestos); TOX (Total Organic Halogen) and TOC (Total Organic Carbon). Blind replicate samples for TOX, TOC, and total phenol were collected for Wells 1 and 2. In addition, a field blank (distilled water) and a trip blank were also analyzed for TOX, TOC, and total phenol. Envirodyne Engineers, St. Louis, Missouri, performed all of the laboratory analyses for this project.

Each of the 2-inch wells was evacuated with a bailer and all three 6-inch wells were evacuated with a submersible pump. Three equivalent casing volumes of water were removed from each monitoring well before sampling. All Sampling was carried out according to a protocol that minimizes the possibility of cross-contamination of samples. Each well was sampled with a bailer that was cleaned after the sampling of each well. Replicate samples were collected in a common container before distributing the water sample to each bottle.

Well water designated for metals analysis would not pass directly through a 0.45 micron filter. Therefore, in accordance with laboratory direction, the acid preservative was rinsed from the metals container and the raw water sample was collected. Upon delivery to Envirodyne Engineers, the metal samples were filtered and acidified by laboratory personnel. All other samples were preserved according to instructions provided by Envirodyne Engineers.

Aquifer Tests

Slug tests were carried out on each of the 6-inch monitoring wells (Wells 1, 2 and 3). A weight of a known volume was lowered down below the water level in each well, and water-level measurements were made of the water-level decline with an electric probe at 15 second intervals. The test begins (to) as soon as the weight is lowered below the water level in the well and the test ends when the water level in the well has declined to the original pre-test static level. The water-level measurements made with time are given in Table 7.

The method used to analyze the slug test data was developed by Cooper, Bredehoeft, and Papadopulos (see: S.W. Lohman, 1972, "Ground Water Hydraulics" U.S. Geological Survey Professional Paper 708.) The technique is applicable to wells screened across the entire thickness of confined aquifers of rather low transmissivity. If the tested well is screened across part of the aquifer, the transmissivity values only apply to that part of the aquifer in which the well is screened or open. Application of the testing technique to unconfined aquifers, such as in the study area, requires judgement. Specifically, moving the data plot from one of the family of type curves to another changes the transmissivity by a small amount, but changes the storage coefficient by a factor of 10. Therefore, the expected water-table coefficient had to be kept in mind in attempting to find the best data fit.

Table 2 summarizes data for Wells 1, 2, and 3. The calculated hydraulic conductivities of the shallow water-table zone ranged from 1.9 to 23 gallons per day per square foot (gpd/ft^2) and averaged 9.5 gpd/ft^2. The calculated transmissivity values ranged from 28.5 to 344.3 gpd/ft and averaged 141.5 gpd/ft. Although the transmissivity and hydraulic conductivities values are low for all three wells, it is important to note from Table 2, that the gravel packing of the remainder of the annular space around the well screen that did not collapse during well installation has apparently increased the calculated aquifer test results.

APPENDIX B

Tables

CER 093585

Table 1. Static Water Levels for Shallow Water-Table Monitoring Wells, Monsanto Company, W.G. Krummrich Plant, Sauget, Illinois.

Well No.	Elevation of Measuring Point (feet above mean sea level)	November 17, 1983 Depth to Water (feet below measuring point)	November 17, 1983 Elevation of Water Level (feet above mean sea level)	December 16, 1983 Depth to Water (feet below measuring point)	December 16, 1983 Elevation of Water Level (feet above mean sea level)	January 31, 1984 Depth to Water (feet below measuring point)	January 31, 1984 Elevation of Water Level (feet above mean sea level)
1	413.65	17.67	395.98	17.51	396.14	15.85	397.80
2	417.37	26.15	391.22	24.36	393.01	24.19	393.18
3	410.14	21.76	388.38	19.29	390.85	19.30	390.84
4	406.43	16.96	389.47	15.59	390.84	14.70	391.73
5	414.94	26.92	388.02	24.35	390.59	24.42	390.52
6	414.59	24.16	390.43	22.33	392.26	22.25	392.34
7	414.95	25.57	389.38	23.50	391.45	23.67	391.28
8	418.49	27.95	390.54	26.00	392.49	26.56	391.93
9	414.47	17.96	396.51	16.17	398.30	17.03	397.44
10	412.97	16.77	396.20	15.41	397.56	15.13	397.84
11	412.95	18.62	394.33	16.87	396.08	16.88	396.07
12	416.47	21.21	395.26	19.38	397.09	18.59	397.88
U.S. Engineers Depot River Gauge	379.58	8.0 b)	387.58	15.7 b)	395.28	4.5 b)	384.08

a) All elevations are referenced to Bench Mark No. 15 (96.06 feet) at the southeast corner of Third and I Streets and have been converted to the NGVD datum. The elevations were determined to the top of the steel well casings for the 2-inch wells and to the top of the recorder shelter base for the 6-inch wells. The conversions to the W.G. Krummrich datum is 413.50 feet (NGVD) equals 101.00 feet (W.G. Krummrich datum).

b) Measurement is in feet above the measuring point.

Table 2. Summary of Results of Slug Testing on Selected Water-Table Zone Wells, Monsanto Facility, Sauget, Illinois.

Well	Transmissivity (gallons per day per foot)	Hydraulic Conductivity (gallons per day per square foot)	Storage Coefficent (dimensionless)	Portion of Screen that is Gravel-Packed (percent)
1	344.3	23.0	0.01	60
2	28.5	1.9	0.1	0
3	51.8	3.5	0.1	20
Average	141.5	9.5	0.07	--

MEASURE OF QUANTITY OF WATER THAT WOULD MOVE UNDER HYDRAULIC GRADIENT

PERCH - STRATA OF WATER SUSPENDED BETWEEN NON-PERMEABLE ZONES

CER 093587

Geraghty & Miller, Inc.

Table 3. Summary of the U.S. Environmental Protection Agency's List of Priority Pollutant Parameters and Selected Indicator Constituents Analyzed by Envirodyne Engineers for Each Ground-Water Sample.

Volatile Organic Compounds

acrolein
acrylonitrile
benzene
bis(chloromethyl)ether
bromoform
carbon tetrachloride
chlorobenzene
chlorodibromomethane
chloroethane
2-chloroethylvinyl ether
chloroform
dichlorobromomethane
dichlorodifluoromethane
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethylene
1,2-dichloropropane
1,3-dichloropropylene
ethylbenzene
methyl bromide
methyl chloride
methylene chloride
1,1,2,2-tetrachloroethane
tetrachloroethylene
toluene
1,2-trans-dichloroethylene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethylene
trichlorofluoromethane
vinyl chloride

Acid Extractable Organic Compounds

2-chlorophenol
2,4-dichlorophenol
2,4-dimethylphenol
4,6-dinitro-o-cresol
2,4-dinitrophenol
2-ntirophenol
4-nitrophenol
p-chloro-m-cresol
pentachlorophenol
phenol
2,4,6-trichlorophenol

Base/Neutral Extractable Organic Compounds

acenaphthene
acenaphthylene
anthracene
benzidine
benzo(a)anthracene
benzo(a)pyrene
3,4-benzofluoranthene
benzo(ghi)perylene
benzo(k)fluoranthene
bis(2-chloroethoxy)methane
bis(2-chloroethyl) ether
bis(2-chloroisopropyl)ether
bis(2-ethylhexy)phthalate
diethyl phthalate
dimethyl phthalate
di-n-butyl phthalate
2,4-dinitrotoluene
2,6-dinitrotoluene
di-n-octyl phthalate
1,2-diphenylhydrazine
(as azobenzene)
fluoranthene
fluorene
hexachlorobenzene
hexachlorobutadiene
hexachlorocyclopentadiene
hexachloroethane

CER 093588

Table 3. (Continued)

Base/Neutral Extractable Organic Compounds (cont'd.)

4-bromophenyl phenyl ether	indeno(1,2,3-cd)pyrene
butyl benzyl phthalate	isophorone
2-chloronaphthalene	naphthalene
4-chlorophenyl phenyl ether	nitrobenzene
chrysene	N-nitrosodimethylamine
dibenzo(a,h)anthracene	N-nitrosodi-n-propylamine
1,2-dichlorobenzene	N-nitrosodiphenylamine
1,3-dichlorobenzene	phenanthrene
1,4-dichlorobenzene	pyrene
3,3'-dichlorobenzidine	1,2,3-trichlorobenzene

Pesticides/PCB's

aldrin	endrin
alpha-BHC	endrin aldehyde
beta-BHC	heptachlor
gamma-BHC	heptachlor epoxide
delta-BHC	PCB-1242
chlordane	PCB-1254
4,4'-DDT	PCB-1221
4,4'-DDE	PCB-1232
4,4'-DDD	PCB-1248
dieldrin	PCB-1260
alpha-endosulfan	PCB-1016
beta-endosulfan	toxaphene
endosulfan sulfate	2,3,7,8-tetrachlorodibenzo-p-dioxin

Metals

antimony	mercury
arsenic	nickel
beryllium	selenium
cadmium	silver
chromium	thallium
lead	zinc

Miscellaneous Indicators

pH	TOC
specific conductance	TOX
temperature	Cyanide
total phenols	

CER 093589

Table 4. Summary of Analytical Results (Inorganic and Indicator Parameters) for Ground-Water Samples Collected During November 15-17, 1983 from Monitoring Wells, Monsanto Company, W.G. Krummrich Plant, Sauget, Illinois (concentrations are in mg/L, except where noted).

Parameter	USEPA Limits[a)]	Well 1	Rep[b)] Well 1	Well 2	Rep[b)] Well 2	Well 3	Well 4	Well 5	Well 6
Indicators									
pH (units)	-	-	-	-	-	8.5	7.8	7.8	7.5
Specific Conductance (umhos)	-	1,200	1,200	3,000	3,000	2,500	1,050	625	2,000
Temperature (°F)	-	53	53	52	52	54	53	52	53
Total Phenols	-	0.020	0.019	0.007	0.003	0.006	0.004	0.003	0.020
TOC	-	66/ 54.5[c)]	22/ 26[c)]	120/ 46.5[c)]	40/ 48[c)]	72	42	36	36
TOX (ug/L)	-	16	20	160	510	540	17	11	110
Cyanide	-	<0.005	-	0.005	-	<0.005	<0.005	<0.005	<0.005
Metals									
Antimony	-	0.011	-[d)]	0.165	-	0.097	0.014	0.009	0.012
Arsenic	0.05	0.017	-	<0.002	-	0.007	<0.002	<0.002	0.007
Beryllium	-	0.023	-	0.019	-	0.027	0.017	0.013	0.012
Cadmium	0.01	<0.01	-	0.030	-	0.020	<0.01	<0.01	0.01
Chromium	0.05	0.411	-	0.048	-	0.051	<0.04	<0.04	<0.04
Lead	0.05	<0.001	-	0.057	-	0.035	<0.001	0.001	0.004
Mercury (ug/L)	2.0	<0.2	-	0.47	-	0.35	<0.2	<0.2	<0.2
Nickel	-	0.08	-	0.18	-	0.09	<0.04	<0.04	0.05
Selenium	0.01	<0.002	-	0.006	-	<0.002	<0.002	<0.002	0.002
Silver	0.05	<0.001	-	0.006	-	0.002	<0.001	<0.001	<0.001
Thallium	-	0.002	-	0.062	-	0.047	0.003	0.004	0.004
Zinc	5.0	0.334	-	3.26	-	6.41	0.014	0.011	0.018

None a substation?

Notes: a) USEPA Drinking Water Standards. All metals, except zinc, are Primary Interim Drinking Water Standards. Zinc is a Secondary Drinking Water Standard.

b) Replicate samples for Wells 1 and 2 were collected in the field. Replicate results for Well 9 were determined by analyzing the same well water twice as an internal check on performance by Envirodyne.

c) The first set of results for TOC were three times higher than the replicate values, therefore, Envirodyne repeated the analysis. The corrected results are reported as the second number of each pair of values.

d) - Analysis was not performed.

Table 4. (Continued)

Parameter	USEPA Limits[a]	Well 7	Well 8	Well 9	Rep[b] Well 9	Well 10	Well 11	Well 12	Field Blank	Trip Blank
Indicators										
pH (units)		7.3	6.8	7.0	-	7.0	7.3	7.9	-	-
Specific Conductance (umhos)		1,150	1,200	8,500	8,500	2,100	1,100	30,000	<50	-
Temperature (°F)		53	54	51	-	52	54	53	60	-
Total Phenols		0.003	0.013	0.190	-	<0.002	0.002	0.68	<0.002	<0.002
TOC		28	84	112	130	72	36	118	2	2
TOX (ug/L)		9	150	750	-	13	22	4,700	<5	13
Cyanide		<0.005	0.021	0.016	-	<0.005	<0.005	0.013	-	-
Metals										
Antimony		0.010	0.012	0.017	0.017	0.011	0.012	0.131	-	-
Arsenic	0.05	0.002	<0.002	0.003	0.005	<0.002	<0.002	0.024	-	-
Beryllium	-	0.010	0.012	0.013	<0.01	<0.01	<0.01	<0.01	-	-
Cadmium	0.01	0.01	<0.01	0.010	<0.01	<0.01	<0.01	0.03	-	-
Chromium	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	-	-
Lead	0.05	0.001	0.005	0.005	0.005	0.004	0.002	0.015	-	-
Mercury (ug/L)	2.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-
Nickel	-	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.13	-	-
Selenium	0.01	0.005	<0.002	0.004	0.003	0.003	0.003	0.034	-	-
Silver	0.05	<0.001	0.002	<0.001	<0.001	0.006	<0.001	<0.001	-	-
Thallium	-	0.002	0.003	0.007	0.006	0.004	0.003	0.023	-	-
Zinc	5.0	0.015	0.010	0.030	0.037	0.049	0.019	0.037	-	-

Notes:

a) USEPA Drinking Water Standards. All metals, except zinc, are Primary Interim Drinking Water Standards. Zinc is a Secondary Drinking Water Standard.

b) Replicate samples for Wells 1 and 2 were collected in the field. Replicate results for Well 9 were determined by analyzing the same well water twice as an internal check on performance by Envirodyne.

c) - Analysis was not performed.

Table 5 . Summary of Analytical Results (Organic Priority Pollutant Compounds) For Ground-Water Samples Collected During November 15-17, 1983 from Monitoring Wells, Monsanto Company, W.G. Krummrich Plant, Sauget, Illinois (concentrations are in ug/L[a]).

Not From Field

Parameters	Well No. 1	2	3	4	5	6	7	8	9	10	11	12	12-Rep[d)]	Laboratory Blank	Blank
Volatile Organic Compounds															
Benzene	-[c)]	-	-	-	-	<1	1	3	331	2	<1	425	433	-	-
Chlorobenzene	-	-	-	-	-	-	-	-	1,270	-	-	350	296	-	-
Chloroform	2	28	11	-	1	3	<1	8	3	<1	5	18	21	-	1
1,1-Dichloroethane	-	-	-	-	-	29	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-		-	-	-	-	-	4	4	-	-
Methylene chloride	18	12	12	9	10	18	11	16	10	21	16	49	64	34	26
Tetrachloroethylene	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
Toluene	-	-	-	-	2	1	<1	-	2	<1	<1	4	4	-	-
1,2-Trans-dichloroethylene	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-
1,1,1-Trichloroethane	5	-	-	-	-	2	<1	6	3	1	<1	8	7	-	-
Trichloroethylene	6	6	<1	-	-	2	<1	-	<1	-	-	-	-	-	-
Acid Extractable Organic Compounds															
2-Chlorophenol	-	-	-	-	-	-	-	-	55	-	-	182	160	-	-
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-
Pentachlorophenol	-	-	-	-	-	-	-	-	58	-	-	147	115	-	-
Phenol	<1	<1	-	-	<1	-	-	<1	<1	-	-	40	38	-	-
Base/Neutral Extractable Organic Compounds															
Bis(2-ethylhexyl) phthalate	<1	13	1	<1	<1	<1	1	1	<1	<1	<1	<1	<1	<1	
Butyl benzyl phthalate	-	-	<1	<1	-	-	-	-	<1	1	-	-	-	-	
1,2-Dichlorobenzene	-	-	-	-	-	-	-	-	33	-	-	366	357	-	
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-	38	-	-	-	-	-	

Table 5. (Continued)

Parameters	Well No. 1	2	3	4	5	6	7	8	9	10	11	12	12-Rep[d)]	Laboratory Blank	Blank
Base/Neutral Extractable Organic Compounds (Cont'd)															
Diethyl phthalate	-	-	<1	<1	-	-	<1	-	-	-	-	-	-	<1	-
Dimethyl phthalate	-	-	-	-	-	<1	-	-	-	-	<1	-	-	-	-
Di-n-butyl phthalate	1	2	2	2	1	2	2	1	1	1	1	2	1	1	-
Naphthalene	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
Nitrobenzene	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-
Phenanthrene[b)]	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Total	32	61	26	11	14	57	15	43	1,828	26	22	1,595	1,500	35	27

Note:
a) This data represents only those compounds which were detected. See Table 3 for the entire list of Organic Priority Pollutants that was examined for each ground-water sample.
b) Phenanthrene coelutes with anthracene; therefore, the peak area is calculated as one compound.
c) - Not detected
d) Replicate results for Well 12 were determined by analyzing the same well water twice as an internal check on performance by Envirodyne.

Table 6. Summary of Construction Details for the Monitoring Wells, Monsanto Company, W.G. Krummrich Plant, Sauget, Illinois.

Well No.	Date Completed	Well Diameter (inches)	Depth (feet below land surface)	Screen Setting (feet below land surface)	Interval Gravel Packed (feet below land surface)	Height of Measuring Point (feet above land surface)	Elevation of Measuring Point (feet above mean sea level)[a]
1	11- 1-83	6	34	19 - 34	16 - 28	2.6	413.65
2	11- 8-83	6	41	26 - 41	None	2.2	417.37
3	11- 7-83	6	36	21 - 36	19 - 24	2.7	410.14
4	11- 2-83	2	28	13 - 28	12 - 14	2.8	406.43
5	11- 3-83	2	36	21 - 36	18.5 - 24	2.5	414.94
6	11- 2-83	2	34	19 - 34	16 - 22	2.0	414.59
7	11- 3-83	2	36	21 - 36	17 - 23	2.5	414.95
8	11- 2-83	2	34	19 - 34	None	2.0	418.49
9	11-10-83	2	28	13 - 28	11.5 - 15.5	2.7	414.47
10	11- 9-83	2	28	13 - 28	11 - 12.5	2.2	412.97
11	10-31-83	2	25	10 - 25	8.5 - 21	2.6	412.95
12	11- 9-83	2	33.5	18.5 - 33.5	16 - 23	3.0	416.47

a) All elevations are referenced to Bench Mark No. 15 (96.06 feet) at the southeast corner of Third and I Streets and have been converted to the NGVD datum. The elevations were determined to the top of the steel well casings for the 2-inch wells and to the top of the recorder shelter base for the 6-inch wells. The conversions to the W.G. Krummrich datum is 413.50 feet (NGVD) equals 101.00 feet (W.G. Krummrich datum).

Table 7. Water-Level Measurements for Determining Aquifer Characteristics Based on Slug Tests Performed on Wells 1, 2, and 3, Monsanto Company, W.G. Krummrich Plant, Sauget, Illinois.

	WELL 1			WELL 2			WELL 3		
Time (sec)	Depth to Water (feet below top of well casing)	H[a]	H/H_o[b]	Depth to Water (feet below top of well casing)	H	H/H_o	Depth to Water (feet below top of well casing)	H	H/H_o
static	27.32	-	-	35.62	-	-	31.26	-	-
0	25.30[c]	2.02	1.00	33.60[c]	2.02	1.00	29.24[c]	2.02	1.00
15	25.83	1.49	0.74	33.91	1.71	0.85	29.62	1.64	0.82
30	26.03	1.29	0.64	33.99	1.63	0.81	29.72	1.54	0.76
45	26.18	1.14	0.56	34.05	1.57	0.78	29.78	1.48	0.73
60	26.29	1.03	0.51	34.09	1.53	0.76	29.84	1.42	0.70
75	26.38	0.94	0.47	34.13	1.49	0.74	29.89	1.37	0.68
90	26.46	0.86	0.43	34.16	1.46	0.72	29.94	1.32	0.65
105	26.53	0.79	0.39	34.19	1.43	0.71	29.98	1.28	0.63
120	26.60	0.72	0.36	34.22	1.40	0.69	30.02	1.24	0.61
135	26.66	0.66	0.33	34.25	1.37	0.68	30.06	1.20	0.59
150	26.72	0.60	0.30	34.28	1.34	0.66	30.10	1.16	0.57
165	26.77	0.55	0.27	34.31	1.31	0.65	30.13	1.13	0.56
180	26.82	0.50	0.25	34.34	1.28	0.63	30.17	1.09	0.54
195	26.86	0.46	0.23	34.37	1.25	0.62	30.21	1.05	0.52
210	26.89	0.43	0.21	34.39	1.23	0.61	30.24	1.02	0.50
225	26.91	0.41	0.20	34.41	1.21	0.60	30.27	0.99	0.49
240	26.93	0.39	0.19	34.43	1.19	0.59	30.30	0.96	0.48
255				34.45	1.17	0.58	30.32	0.94	0.47
270				34.47	1.15	0.57	30.35	0.91	0.45
285				34.49	1.13	0.56	30.38	0.88	0.44
300				34.50	1.12	0.55	30.40	0.86	0.43
315				34.51	1.11	0.55	30.43	0.83	0.41
330							30.46	0.80	0.40
345							30.48	0.78	0.39

Table 7. (Continued)

	WELL 1			WELL 2			WELL 3		
Time (sec)	Depth to Water (feet below top of well casing)	H[a)]	H/H_o[b)]	Depth to Water (feet below top of well casing)	H	H/H_o	Depth to Water (feet below top of well casing)	H	H/H_o
360							30.50	0.76	0.38
375							30.52	0.74	0.37
390							30.54	0.72	0.36

Note: a) H - head inside the well at time t after injection of the slug (steel weight) above the initial head.

b) H_o - head inside the well above the initial head at instant of injection of the slug (steel weight).

c) The increase of head at the instant of lowering the slug (steel weight) into the water table is equal to 2.02 feet.

APPENDIX C

Figures

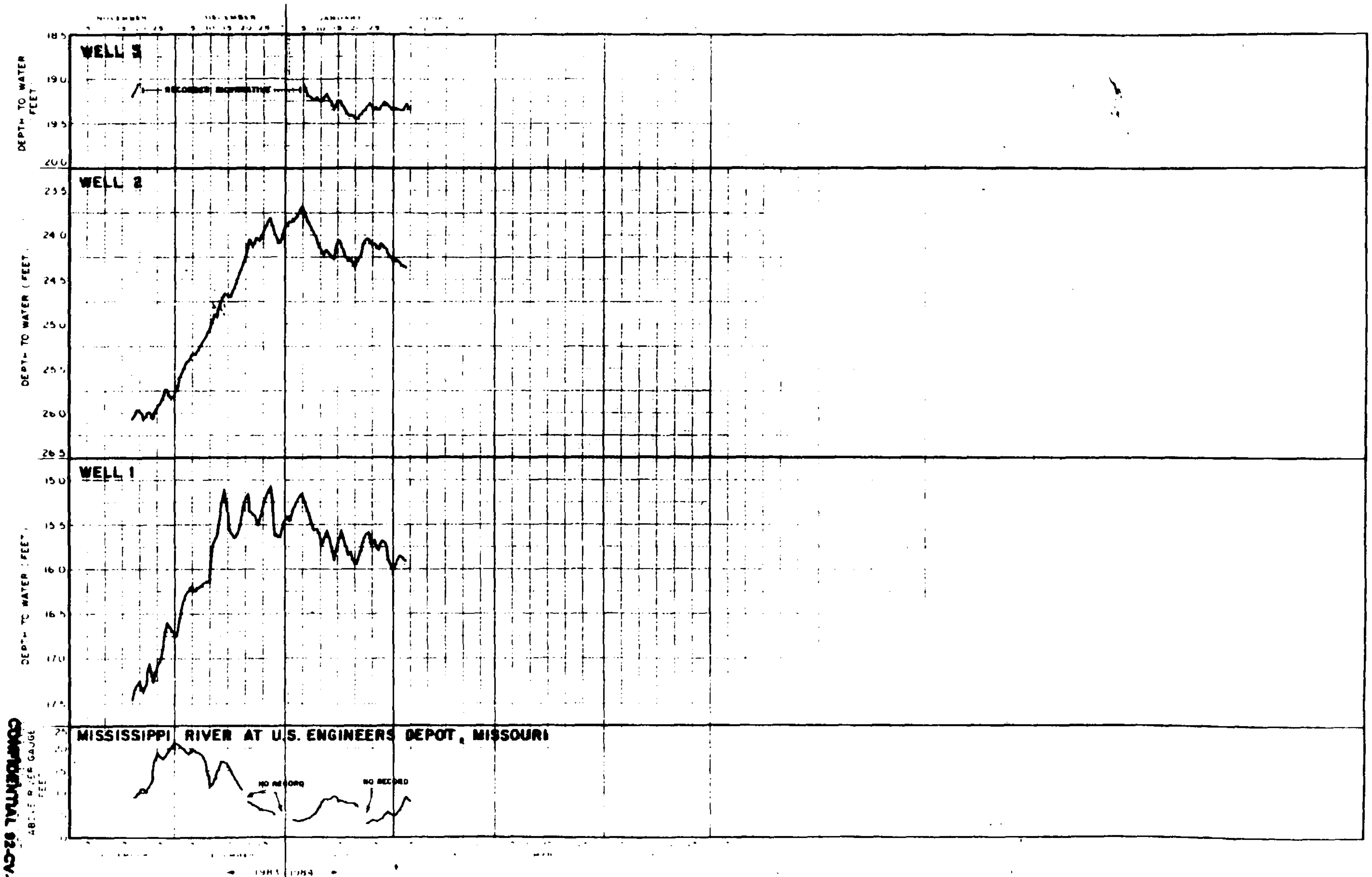

FIGURE 4 - HYDROGRAPHS FOR WELLS 1, 2, 3 AND THE MISSISSIPPI RIVER

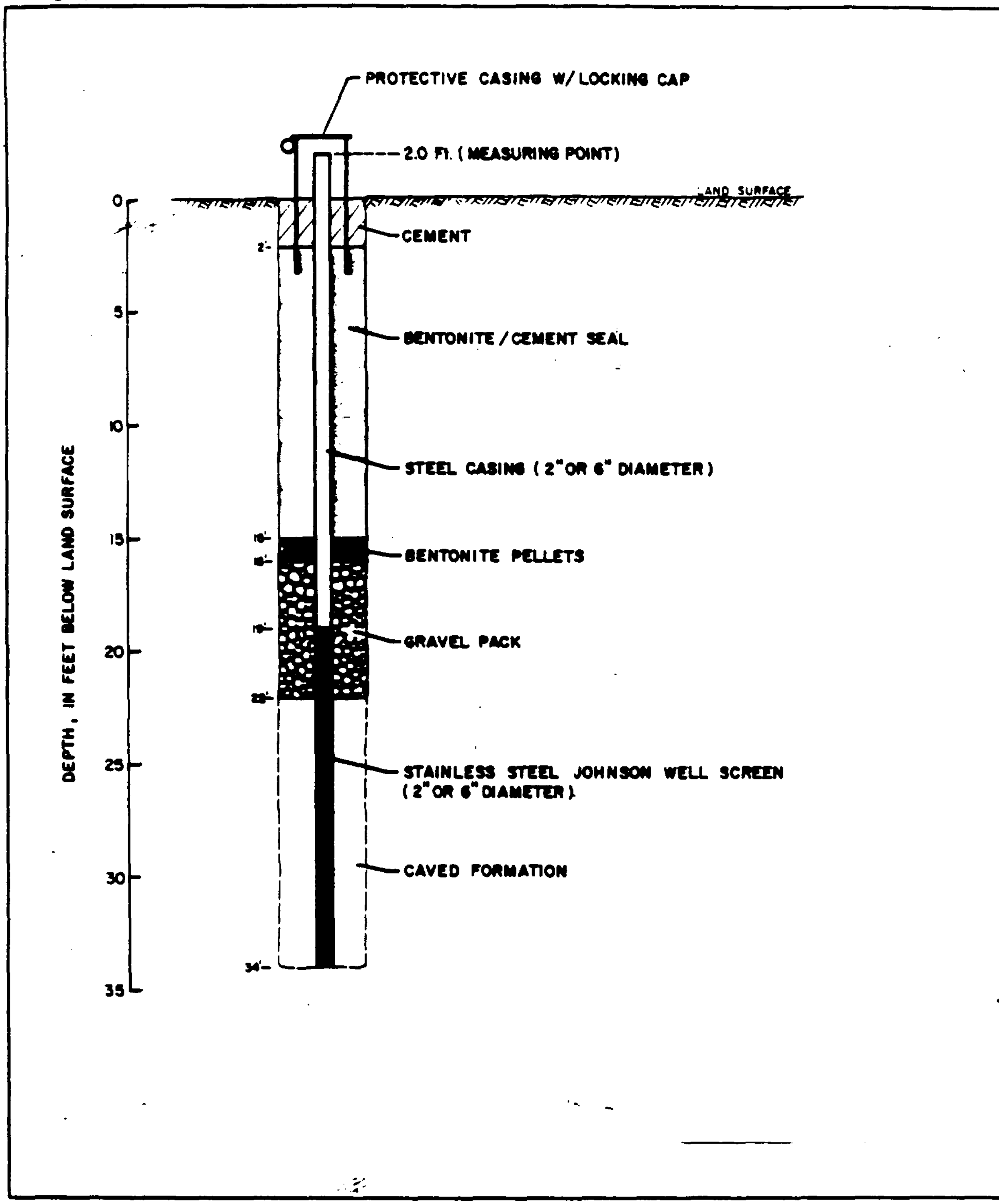

FIGURE 10 - CONSTRUCTION DETAILS FOR 2-INCH AND 6-INCH MONITORING WELLS, Monsanto, Sauget, Illinois

CER 093615

APPENDIX D

Geologic Logs

Geraghty & Miller, Inc.

DR[illegible]
SUBJECT [illegible]

NOT FOR RE[illegible]
OR FURTHER DISTRIBU[illegible]

GEOLOGIC LOGS

Description	Depth (feet)
Well 1	
Silt, clayey, brown	0 - 3.5
Sand, very fine, silty; tan	3.5 - 6
Silt, clayey, gray and brown	6 - 12
Sand, very fine, very silty, gray	12 - 22
Sand, fine, silty, gray	22 - 32
Sand, fine to medium, gray; trace of coarse sand	32 - 36
Well 2	
Gravel (fill)	0 - 2
Sand, very fine to fine, silty, gray and yellowish-brown	2 - 7
Clay, silty, gray	7 - 12
Sand, very fine to fine, tan	12 - 18
Silt, sandy, gray	18 - 20
Sand, very fine to fine, silty, gray	20 - 21
Sand, very fine to fine, brown; some silt	21 - 35
Sand, fine to medium, gray	35 - 44
Well 3	
Sand, very fine to fine, brown; some silt	0 - 2
Sand, very fine to fine, tan	2 - 10
Silt, sandy, brown	10 - 12
Sand, very fine to fine, very silty, brown	12 - 15
Sand, very fine to fine, tan: trace silt	15 - 22
Sand, fine to medium, brown and gray	22 - 32
Sand, fine to medium, brown; some coarse sand and fine gravel	32 - 36

CER 093617

GEOLOGIC LOGS (cont.)

Description	Depth (feet)
Well 4	
Clay, dark brown	0 - 3
Sand, very fine, very silty, tan	3 - 7
Sand, fine, tan	7 - 17
Sand, fine, brown; some silt	17 - 22
Sand, fine to medium, brown; trace trace coarse sand	22 - 28
Well 5	
Sand, very fine to fine, brown; some silt	0 - 2
Sand, very fine to fine, tan	2 - 27
Sand, very fine to fine, tan; some medium sand	27 - 36
Well 6	
Sand, very fine, silty, dark gray	0 - 3
Sand, very fine, silty, tan	3 - 8
Clay, gray; some silt	8 - 13
Sand, very fine, tan	13 - 21
Sand, very fine, tan; some silt	21 - 27
Sand, fine, silty; trace of medium and coarse sand	27 - 32
Sand, fine to medium, gray; trace of coarse sand	32 - 36
Well 7	
Silt, sandy, brown	0 - 1
Sand, very fine, brown; some silt	1 - 4
Silt, gray	4 - 5
Sand, very fine, gray; some silt	5 - 12
Sand, very fine, tan	12 - 22
Sand, very fine, brown; some silt	22 - 27
Sand, very fine to fine, brown; some medium sand	27 - 36

GEOLOGIC LOGS (cont.)

Description	Depth (feet)
Well 8	
Sand, very fine, silty, brown	0 - 2
Sand, very fine, tan	2 - 14
Silt, gray and brown	14 - 14.5
Sand, very fine, tan	14.5 - 22
Sand, very fine, brownish-gray; some silt	22 - 27
Sand, very fine to fine, gray; some silt and medium sand	27 - 36
Well 9	
Gravel (fill)	0 - 2
Cinders, black (fill)	2 - 3
Sand, very fine to fine, silty, brown	3 - 12
Clay, silty, gray	12 - 14
Sand, very fine to fine, silty, brown	14 - 22
Sand, very fine to fine, silty, gray (slight odor)	22 - 28
Well 10	
Topsoil	0 - 1
Silt, sandy, brown	1 - 6
Sand, very fine to fine, very silty, brown	6 - 28
Well 11	
Silt, sandy, brown	0 - 2
Gravel, coarse (fill)	2 - 3
Silt, clayey, gray; trace gravel	3 - 9.5
Sand, silty, fine, tan	9.5 - 17
Sand, very silty, very fine, gray	17 - 26

GEOLOGIC LOGS (cont.)

Description	Depth (feet)
Well 12	
Cinders and gravel, black (fill)	0 - 8.5
Clay, gray	8.5 - 17
Silt, clayey, gray	17 - 18.5
Sand, very fine to fine, very silty, gray (odor in samples)	18.5 - 22
Sand, very fine to fine, gray; some silt (odor in samples)	22 - 35.5